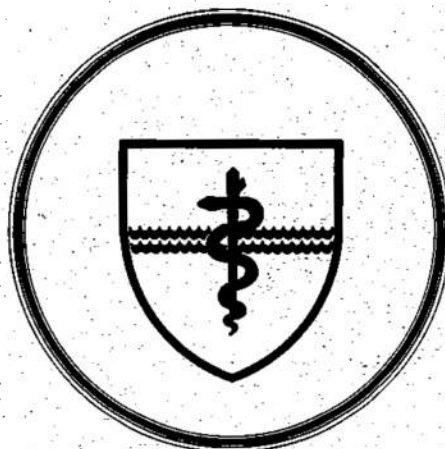


# NAVAL SUBMARINE MEDICAL RESEARCH LABORATORY

## SUBMARINE BASE, GROTON, CONN.



REPORT NUMBER 1029

LEAKAGE INTO THE NAVY OXYGEN BREATHING APPARATUS  
WHEN WORN OVER SPECTACLES

by

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Naval Medical Research and Development Command  
Research Work Unit M0100.001-1020

Released by:

W. C. Milroy, CAPT, MC, USN

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Naval Submarine Medical Research Laboratory

7 September 1984



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## SUMMARY PAGE

### PROBLEM

To measure the leakage into the Oxygen Breathing Apparatus when worn over eyeglasses.

### FINDINGS

The OBA permits relatively little leakage, considerably less than the other two masks carried on submarines, as long as the eyeglass frame is small enough to fit under the mask. The eyeglass insert designed to be specifically used with the mask was rated less comfortable than the other frames, although there were complaints about the comfort of all of them.

### APPLICATION

These findings indicate that the OBA is the most satisfactory of the three masks carried on submarines in terms of the amount of leakage it permits and the ability to wear the mask over some eyeglass frames.

### ADMINISTRATIVE INFORMATION

This research was conducted as part of the Naval Medical Research and Development Work Unit M0100.001-1020 - "Correcting vision in emergency breathing masks." It was submitted for review on 6 Aug 1984, approved for publication on 7 Sep 1984, and designated as NSMRL Report No. 1029.

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# ABSTRACT

The proportion of submariners wearing eyeglasses has increased considerably in the last generation, raising the question as to how much leakage occurs when emergency breathing masks are worn over eyeglasses. The amount of leakage into the Oxygen Breathing Apparatus (OBA) was measured when it was worn over five different types of eyeglass frames as well as with no frames by shaven and bearded men. If the frame was small enough to fit under the mask, there was relatively little leakage compared with the other two masks carried on submarines. All the frames except the Standard Navy issue S-10 frame (which would not fit under the mask) were rated as reasonably comfortable, although the spectacle insert specifically designed to be used with the OBA was not rated as highly as the other frames.



## INTRODUCTION

Submarines carry three types of emergency breathing masks in the event that the atmosphere in a submarine becomes contaminated. Whichever mask is used, there may be problems achieving a satisfactory seal around the head if eyeglasses are worn under the mask. Since nearly half of the young men of military age in the country now wear eyeglasses (1,2), the chances of such a problem arising are substantial. The crewman then has the choice of wearing his glasses and risking leakage of contaminated air into the mask or taking his glasses off and suffering from reduced visual acuity as he tries to carry out his duties. Since many tasks on the submarine require 20/20 vision (3,4), some men will not be able to carry out their duties with complete efficiency if they must remove their glasses in order to wear the mask. In previous studies, the amount of leakage into the Emergency Air Breathing Mask (EAB) (5) and the Mark V Chemical-Biological Mask (6) was measured when worn over various eyeglass frames. In this investigation, we measured the leakage into the Oxygen Breathing Apparatus (OBA) which provides oxygen from tanks carried on the chest (Fig. 1), when worn over five different types of eyeglass frames.

## METHODS

### Subjects

Eight men, four clean-shaven and four bearded, volunteered to serve as subjects. All were members of the Lab.

### The Spectacle Frames

The amount of leakage into the OBA was measured with the subjects wearing one of five different spectacle frames or no frames. The frames were the standard S-10 Navy issue, the Sampson P-3 gold wire frame, the P-3 matte chrome wire frame, the U. S. Army combat frame, and the frame insert especially designed to be used with the OBA (Fig. 2). The latter does not have any temples extending from the lens holder to the ears, because it is usually around such temples that leakage occurs. Instead, the frames are held in position by wires which fit snugly against the interior rim of the mask.

### Procedure

The OBA was tested without the oxygen cannisters. The intake and outflow pipes were left exposed to the room air. The subjects put the mask on and adjusted the fit to their own satisfaction. They tested the seal around their heads by cupping the intake tube and trying to inhale. When the mask was sealed against the head, it was not possible to inhale.

In order to measure leakage into the mask, it was worn under a plastic hood which permitted the intake and outflow tubes to protrude into the room air. The intake tube hung in front of the subject, while



Fig. 1. The Oxygen Breathing Apparatus. Oxygen is obtained from a tank carried on the chest which is not shown in the photograph.

the outflow tube was draped over his shoulder and behind his back (Fig. 3). A mixture of 4% helium in air (21% oxygen, 74% nitrogen, 4% helium, and 1% argon) was continuously bled into the space between the hood and the mask. Helium was used as the marker gas because of its relatively high diffusion through materials and because its atomic weight and mass are similar to that of tritium, the radioactive contaminant of principal concern aboard submarines.

Two probes, one inside the hood and one projecting through the hood and into the mask, sampled the air (Fig. 4). The amount of helium in both air spaces was measured with a Perkin Elmer Medical Gas Analyzer, Model 1100. Readings were taken every minute and the run was terminated when they had been stable for 3 minutes. In no case was a run continued for more than 15 minutes. A reading of 4% helium indicated the maximum possible concentration; such a reading inside the mask indicated 100% leakage--a complete lack of any seal and no protection at all. A reading of 1% inside the mask indicated a leakage of 25%.

At the end of each run, the subject rated the frames for comfort on a scale of 1 to 10. The rating of 10 indicated that no discomfort from the frames was felt; by definition, therefore, the rating would be 10 when no frames were worn. A rating of 1 indicated maximum discomfort.



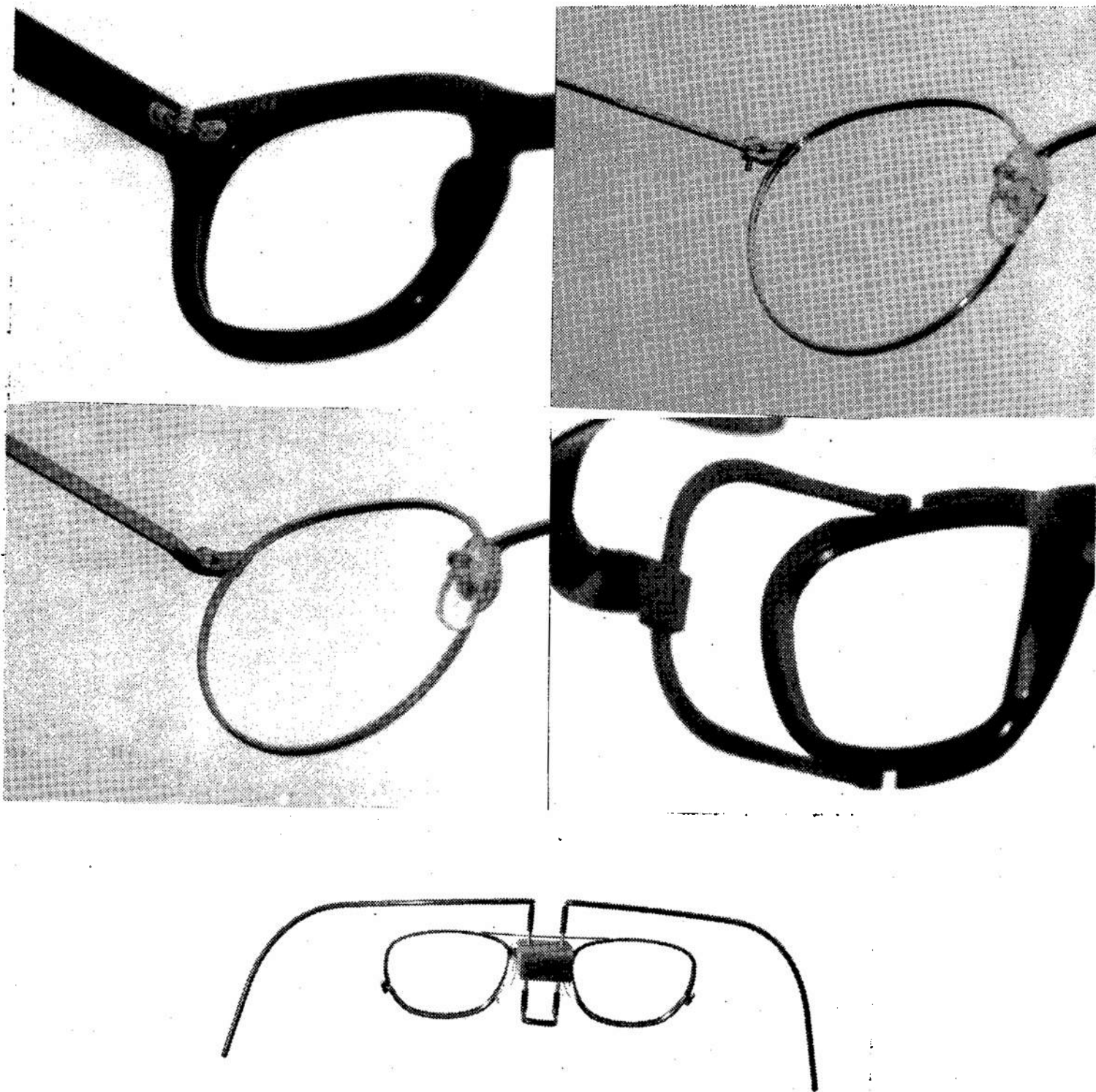


Fig. 2. The eyeglass frames tested. The Navy standard issue S-10 (upper left), the Sampson P-3 gold wire frames (upper right), the Sampson P-3 matte chrome (middle left), the Army combat frame (middle right), and the OBA spectacle insert (bottom).

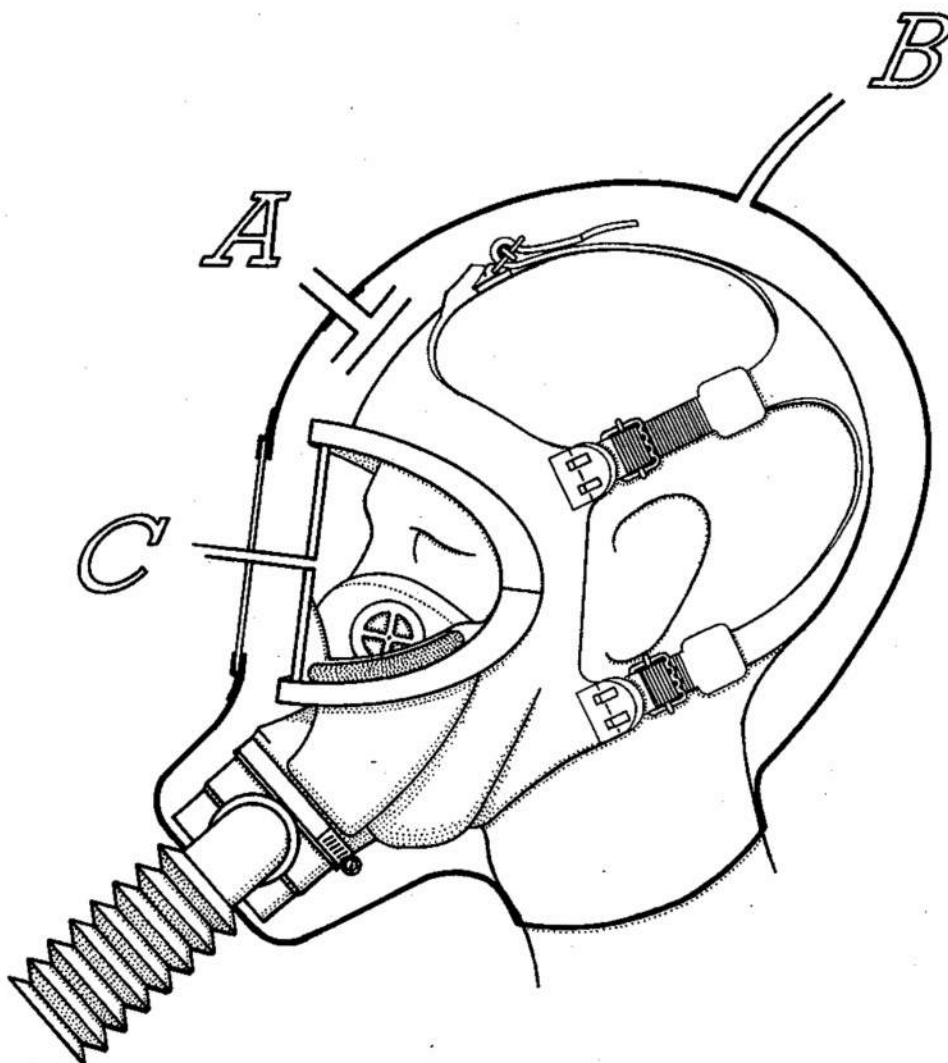


Fig. 3. Leakage into the mask was measured by bleeding a helium-air mixture into the space between a plastic hood and the mask. The hood covered the mask, but the intake and outflow tubes of the mask were exposed to room air. The helium-air mixture was bled through tube A. The presence of helium was detected inside the hood by probe B and inside the mask by probe C.

After making the rating, the subject was given a brief rest, and he then put on a new pair of frames. The mask and hood were put on again, and another run was carried out. Each subject wore the various frames in a different and counterbalanced order.

#### RESULTS

Table I gives the percentages of leakage into the mask when it was worn over the various frames by all eight subjects. The figures are the ratios of the percent helium detected inside the mask to the percent helium detected inside the hood (about 4% of course).

Except for the S-10 standard Navy issue frame, there was very little leakage into the OBA. When wearing no frames, the mean percentage of leakage was less than 1% for the shaven subjects and 1.35% for the bearded ones. The greatest amount of leakage, for the P-3 wire frames worn by the bearded men, was only a little more than 2%.

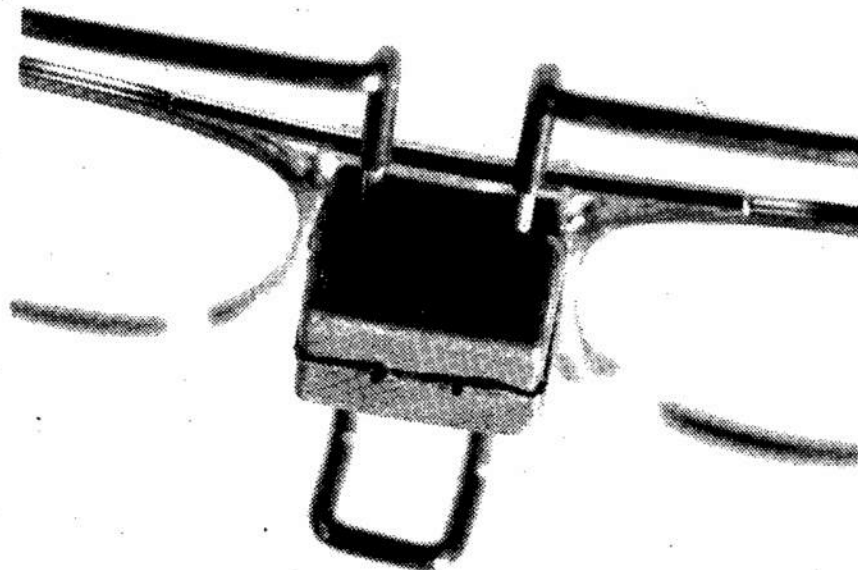


Fig. 4. The cushion on the front of the OBA spectacle insert is designed to press against the faceplate of the mask. It is too thick to fit comfortably between the mask and the bridge of some subjects' noses.

Table I. Percentage of helium leakage into the Oxygen Breathing Apparatus worn over various spectacle frames by clean-shaven and bearded men. The mean comfort ratings of each frame are also shown.

SUBJECTS	CLEAN-SHAVEN					
	No Frames	S-10	P-3	Chrome	Combat	OBA
GB	0.97	100	0.97	1.14	0.41	1.01
RR	1.05	100	1.28	2.23	0.82	1.05
DN	0.82	100	1.41	1.22	0.76	0.82
HF	1.06	100	1.29	2.40	1.08	1.06
Mean	0.98	100	1.24	1.50	0.77	0.99
BEARDED						
DK	1.06	100	1.10	0.95	0.94	1.06
BG	1.05	100	3.14	2.54	1.54	1.29
WA	1.50	100	2.12	1.99	1.50	2.49
AJ	1.78	100	2.36	2.50	1.84	1.74
Mean	1.35	100	2.18	2.00	1.46	1.65
Grand Mean	1.16	100	1.71	1.75	1.12	1.32
Mean Comfort Rating	10	1	6.81	7.50	7.37	6.37

In the case of the S-10, the mask simply could not be worn over these relatively large frames. Even if the subject were willing to endure a great deal of discomfort, no seal could be obtained; the mask was generally separated from the face by about half an inch to an inch.

Table I also gives the mean comfort ratings by the 8 men. Any attempt to seal the mask over the S-10 frames was very uncomfortable, and these frames earned a mean rating of 1 by default. The other four frames were rated as being reasonably comfortable.

## DISCUSSION

The OBA is clearly superior to the other two masks carried on submarines insofar as it can be fitted against the head to prevent significant leaks. Whereas the Emergency Air Breathing Mask showed leaks of nearly three percent when worn by shaven subjects without eyeglasses (5), and the Mark V had a leak of nearly two percent (6), the OBA had a leak of only about one percent. With the bearded subjects, the rates of leakage for the EAB and Mark V were five and eight percent respectively, compared to a little over one percent for the OBA. And the rate of leakage into the OBA seems to be less affected by the variations in shape of the wearer's heads than were the other two masks.

Moreover, the OBA can be sealed more effectively when worn over eyeglass frames unless, as in the case of the S-10, the frames are simply too large to fit under the mask. Such unexpected results as the lower amount of leakage for GB with the combat frames than with no frames at all are presumably due to the tightness with which the subject chose to put on the mask. Often, putting on a pair of frames called the subject's attention to the need to tighten the mask, and he might spend considerable time doing so; if the frame fit comfortably, he was willing to tighten it quite securely. With no frames, subjects took less time to tighten the mask and apparently might do so less securely, although the rate of leakage, as already noted, was quite low.

Although none of the frames except the S-10 caused appreciable leakage, most of the subjects complained about the comfort of the frames. How much they complained was related more to their own facial anatomy than to a particular pair of frames. Interestingly enough, the inserts specifically developed for the OBA were rated less comfortable than any of the other three frames which fit under the mask. The reason seemed to be the cushion in front of the insert which is designed to keep it pressed against the face of the mask (Fig. 5). For several subjects, the cushion was too large and pressed the frame too tightly against the bridge of the wearer's nose. It is possible that a man with his own insert could shave the cushion down to produce a better fit with his own face.

However, Table I shows that the combat frames provide as good a seal as the OBA insert and were rated as slightly more comfortable. It appears, therefore, that the combat frames could not only be used just as effectively as the OBA insert but would, in addition, serve as a spare

pair of glasses for the wearer. Moreover, they could be worn under the other two masks (although they result in more leakage with them, (5,6) something that cannot be done with the OBA insert. There would be no additional bother, since each man has to carry his own refractive corrections, and the combat frames are much more convenient to carry around than the OBA insert with its long, stiff wires.

In general, the subjects concluded that the mask would have been much more comfortable when worn over frames if the manufacturer had designed a larger mask which left more room in front of the face in which to wear eyeglasses.

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